NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MAY 7, 1903.

THE SCIENCE OF FLOUR MILLING.

Le Froment et sa Mouture. Par Girard et Lindet. Pp. vii+355. (Paris: Gauthier-Villars, 1903.) Price 12 francs.

AT the time of the regretted death of Prof. Girard in 1898, much valuable scientific work had been accomplished by him, and the results given to the world at large. But as must almost of necessity occur when a busy man is taken away from his labours, there also remained some tasks commenced but not completed. Among these was a projected treatise on flour milling, of which, however, Prof. Girard left but the general plan and the unfinished manuscript of three chapters. These materials were entrusted to M. Lindet, who has completed the work and supplied the book now before us. The author refers to the fact that neither himself nor Prof. Girard was a practical miller, but that the book is the production of two men of science. An examination of its pages shows it to possess those merits which might be expected from the previous training of the writers, and also, it must be added, the defects which spring from the same cause.

The first chapter deals with the production of wheat in various French districts, and also with the corn markets of Paris and the provinces. In passing, it may be noted that in France, as well as in England, they still suffer from the adoption of different systems of weights and measures in the different local corn markets. Thus, Troyes has a unit of 121 kilos., while La Charente adopts 80 kilos. as its measure, and other markets intermediate quantities. The authors deplore the grave inconveniences which result from such differences, and look forward to a time when the metric quintal shall have been universally adopted. With France as the birthplace of the metric system, there is perhaps some consolation in knowing that England is not the only country ruled in this matter by old-fashioned conservatism.

Following on this introduction, the writers next deal with the chemical composition and the alimentary value of the different parts of the wheat grain. The botanical distinctions between such parts and their separation and estimation are first described, tables being given which show the relative percentages of envelopes, germ, and flour-producing kernel or endosperm in leading types of wheat. The histology, chemical composition, and analysis of the envelope are next given, particular attention being devoted to the constitution of cerealin and the important *rôle* it plays in the process of panification. In pursuit of this line of investigation, the influence of the various parts of the envelope on those milling products which ultimately find their way into the flour is examined very minutely. The experiments and arguments of Mège-Mouriès are followed closely, and his conclusions to the effect that the inclusion of branny particles in flour results in the production of dark-coloured and inferior bread are fully endorsed. The authors further conclude that the branny matters of wheat are devoid of utility for purposes of human alimentation, being practically undigested by man, and consequently inassimilable. An experiment made by Prof. Girard on himself is described at full length. Being in perfect health, and with the digestive faculties in excellent condition, he ate a quantity of pure wheat grain envelopes, and analysed these when excreted at the close of the process of digestion. The necessary precautions were of course taken to ensure exact and trustworthy data being obtained, and Prof. Girard's results show that there is practically no assimilation of proteid bodies from the bran ingested. There is, however, a certain absorption of mineral substances, but this only amounts to 4 grams of mineral matter per kilogram of bread made from "entire flour" (wholemeal). Having regard to the quantity and variety of such matter in a modern diet, the authors regard the gain of these 4 grams as having no serious importance, and, in a word, condemn entirely and without reserve the inclusion of the bran in wheaten flour.

In studying the action of the germ, the authors are impressed with the fact that fresh germ has a characteristic odour and flavour which are in themselves pleasant. They further recognise that germ contains

a large percentage of proteid and oily matter, in consequence of which the nutritive value is high. But the proteid matter contains an active ferment, and the oil is of a highly oxidisable nature, readily becoming rancid. For these reasons they do not hesitate to assert that the germ, as well as the bran, should be rejected in the act of making flour, the farinaceous endosperm being the only component of the wheat grain which ought to be used as human food. It is interesting to note that the problem of the utilisation of germ has been much more successfully attacked in England than on the Continent. The credit is due to an English miller of discovering the fact that on subjecting germ to the action of slightly superheated steam the diastasic properties of the proteids are destroyed, while the oil is so fixed as to lose its natural tendency to rancidity. Germ treated in this manner and then mixed with ordinary white flour produces a bread of pleasant flavour and of high nutritive value.

The endosperm or kernel of wheat consists principally of proteid matters, starch, and products of starch hydrolysis. Of these substances the proteid matter has received the closest attention, the whole general character of each particular variety of wheat, and of its resultant flour, being governed by the quantity and quality of the proteid bodies contained. It has been recognised from the time of Liebig to the present that the proteid matter of wheat is not a single compound, but a mixture of several distinct substances. Among these are small quantities of bodies soluble in water or dilute saline solutions respectively (albumins and globulins); but the greater portion is not soluble in either of these reagents, but forms with water a tough india-rubber-like body, to which the name of gluten has been given. This substance is readily prepared by carefully kneading and washing in a stream of water a piece of dough from wheaten flour. The starch and soluble matters are thus eliminated, and the gluten remains behind. The body thus obtained, known as wet gluten, contains about two-thirds of its weight of water, the remainder being approximately pure proteid. By appropriate means, gluten is capable of being separated into two, and possibly three, different substances, possessing distinct and characteristic chemical and physical properties.

The most exhaustive examination of these bodies has been made by Osborne and Voorhees, who in 1893 communicated their results to the *American Chemical Journal*. Following much the same lines of research as other investigators, they treated gluten and flour itself respectively with dilute alcohol (0·90 specific gravity). This reagent dissolves a considerable quantity of proteid matter from both the previously washed gluten and the untreated flour, the proteid being the same in both instances. (Albumin and globulin are insoluble in dilute alcohol.) To this proteid the name of gliadin has been given. Of gluten, the insoluble portion has been called glutenin. Osborne and Voorhees describe gliadin as being, when obtained in the dry state from a solution in weak alcohol or water, an amorphous transparent substance closely resembling pure gelatin in appearance. It is slightly soluble in distilled water, but is instantly precipitated by a trace of common salt. Gliadin is very soluble in dilute alcohol (70 to 75 per cent.). As may be assumed from its mode of preparation, glutenin is insoluble in such alcohol, and also in water and dilute saline solutions. When freshly precipitated and hydrated, glutenin is soluble in 0·1 per cent. potash solution, and also in the slightest excess of sodium or potassium carbonate solution. Osborne and Voorhees made analyses of spring and winter American wheat flours respectively, each of which is a perfect flour of its kind, and found them to yield gliadin and glutenin in the following proportions :—

	Spring flour.	Winter flour.
Gliadin	45·8 ...	48·4
Glutenin	54·2 ...	51·6
	100·0	100·0

These quantities are roughly, it will be noticed, half and half, whereas M. Fleurent, whose results are adopted by MM. Girard and Lindet, states that the ideal composition of gluten is 75 parts of gliadin to 25 parts of glutenin. With such a composition the resultant bread will be well-risen and easy of digestion; but if the proportion of gliadin is higher, the bread will rise well during fermentation, but will fall in the oven, thus producing a heavy loaf as the result of the liquefaction of gliadin in the presence of water, under the influence of heat. But if the glutenin be in excess, the dough will be comparatively inelastic, and will not rise in baking.

There is evidently a great discrepancy between the results obtained by Osborne and Voorhees and those given in the work before us. It is to be regretted that MM. Girard and Lindet do not point out more clearly that in determining the percentage of gliadin M. Fleurent has made a radical departure from the method of Osborne and Voorhees. Instead of using pure dilute alcohol as a solvent, M. Fleurent employs 70 per cent. alcohol containing 3 parts of caustic potash per 1000. If, as stated by Osborne and Voorhees, glutenin is soluble in 0·1 per cent. potash solution, it is evident that it is readily soluble in a solution of the strength employed by M. Fleurent. After thus dissolving in dilute alcoholic potash solution, M. Fleurent passes carbon dioxide gas to saturation; but although potassium carbonate is insoluble in absolute alcohol, it is soluble in alcohol of 70 per cent., and so one has at the close of the experiment, not a solution of gliadin in dilute alcohol, but a solution of gliadin and a portion of the glutenin in a dilute alcohol-and-water solution of potassium carbonate. It is in consequence of this difference in their respective methods that the proportions of gliadin and glutenin found by these investigators differ so markedly from each other. No reflection whatever is cast upon the method of M. Fleurent as a means of judging the quality of a sample of flour, but it is unfortunate that the separation thus obtained is throughout spoken of by MM. Girard and Lindet as being one of gluten into gliadin and glutenin.

The examination of the more purely chemical part of this book has occupied space to the exclusion of the other subject-matter of the book. In later chapters

are contained an interesting historical *résumé* of the development of milling processes, which in turn is followed by a detailed description of wheat-storing buildings, silos, elevators and the like. The whole process of wheat cleaning, both by dry and wet methods, is described. In the next place, there is an account of the reduction of grain to flour, both by the old mill-stone process and the more modern one of gradual reduction by means of roller mills. The plan-sifter and other methods of separating flour from bran and germ next occupy attention. Having thus traced the whole operation from the raw grain to the finished flour, the authors devote a concluding chapter to flour analysis, modes of preservation, and a description of the channels through which, as a matter of commerce, it reaches the consumer. Of particular interest in this connection is the description of the "Twelve Marks" Market of Paris, and its mode of classifying and valuing flour according to a carefully selected standard of quality.

That M. Girard did not live to see the completion of his work is a matter sincerely to be regretted, but M. Lindet is to be congratulated on having produced, from the materials placed at his disposal and his own researches, a work of the keenest interest to chemists, and one that should prove of great value to the milling industry.

WILLIAM JAGO.

PHYSIOLOGICAL RESULTS.

Ergebnisse der Physiologie. Erster Jahrgang. II. Abteilung. Biophysik und Psychophysik. Pp. xviii+926. (Wiesbaden: Bergmann.) Price 25 marks.

IN the present day, when the man of science is becoming more and more overwhelmed by the ever-increasing flood of literature, any methods which can assist him in some degree to surmount the flood may cordially be welcomed. Year-books and Centralblätter are useful in affording abstracts of current literature, but such abstracts, necessarily disconnected, are apt to engender disconnection and incompleteness of thought in their readers. Moreover, mixed fragments of literature are exceedingly difficult to assimilate, in comparison with connected and critical surveys extending over a definite range of some stated subject. We must therefore express our warm approval at the publication of the first volumes of this new physiological annual. As the name might imply, this "Ergebnisse der Physiologie" is comparable in character to the well-known "Ergebnisse der Anatomie und Entwickelungsgeschichte," which has proved of great service to zoologists, and to the no less valuable "Ergebnisse der allgemeinen Pathologie." In the words of the editors (L. Asher and K. Spiro), the present "Ergebnisse" will consist of original and critical essays upon various subjects or special points in physiology, which as the result of fresh research have acquired an especial interest. As the "Ergebnisse" will appear annually, they hope that in course of time as far as possible every branch of the science will receive its due attention.

With this commendation, we may perhaps be permitted to offer some little criticism as to the range of subjects which the editors propose to include within their jurisdiction. Dealing only with what they term "Biophysik" and "Psychophysik," with which the volume under review is alone concerned (and which represent only half the complete annual), it appears that in addition to purely physiological matters, the editors intend to include essays covering a wide range of general physiology. The physiology of protoplasm is, of course, quite rightly included, but it is distinctly open to question whether biological problems such as inheritance and adaptation had not better be omitted. The present volume of "Ergebnisse," for instance, includes a very long article on Regeneration, although this subject is dealt with regularly every year in the aforementioned "Ergebnisse der Anatomie." Again, the editors intend to include articles on physiological psychology (*e.g.* simple psychical processes, reaction time, sleep, hypnotism). All these extraneous subjects go to swell the size of the volumes, and render them unwieldy. Thus this first year's issue runs to two volumes of about 900 pages each, or double the bulk of the anatomical "Ergebnisse," which in its earlier numbers much more reasonably confined itself to a single volume of about 700 pages. There must be many a working physiologist who would gladly subscribe to a volume of this character, but who would be deterred by the bulkiness and expense of the present issue. Moreover, it is difficult to see how the multiplication of articles in the present "Ergebnisse" can be kept up in the future, unless special points be dealt with in wholly unnecessary detail. So great is the total amount of ground covered that it almost seems as if one or two more years' issues would include the whole range of physiology. Subsequent essayists would accordingly have to rely almost entirely on new work, or their articles would practically resolve themselves into year-book abstracts. It is to be hoped, therefore, that the editors may see fit in future years to curtail the size of their volumes. This should be done, not only by diminishing the number of articles, but by diminishing their length. Many of the essays in the present volume, as, for instance, those of Prof. Tigerstedt on intracardial pressure, of Prof. Starling on the movements and innervation of the alimentary canal, and of Prof. Hensen on the physiology of hearing, are of a moderate and most convenient length; but others, such as those of C. v. Monakow on cortical localisation (132 pages), of A. Tschermak on adaptation of the eye to light, and the function of the rods and cones (106 pages), and of F. B. Hofmann on vision as affected by strabismus (46 pages), must be regarded as unnecessarily detailed, admirable as they may be in themselves. On the other hand, one or two articles err on the side of brevity, especially that of H. Boruttau on the innervation of respiration (6 pages), and to a less extent that of H. Meyer on nerve and muscle poisons (15 pages).

Another matter deserving of criticism is one which in future issues will doubtless to some extent be rectified. It concerns the lack of uniformity in the treatment of their subjects observed by the various essayists.